industry sit agape while enjoying phrases which have as much meaning to them, and to the speaker, as "that blessed word Mesopotamia" to a village crone. But, surely, there must be a limit to their endurance. Even from the point of view of the most practical of "practical men" it must be a serious thing to find, in one line containing eleven words and ten figures, the ratio of the watt to the horse-power made seventeen times larger than it really is, a decimal point misplaced so that the watt is made ten times less than it really is, the vulgar fraction from which the ratio is deduced in decimals inverted, and the essential statement as to the time in which the work is done omitted in a calculation of power.

If men are to be "practical" and nothing else, they must at all events be accurate. If they are to use formulæ which they do not understand, they must at all events know how to use them correctly. If the representative of a great firm—in explaining the answer to a question, which is not sprung upon him unawares, but which he himself puts forward as one which he has been "frequently" asked, and to which, therefore, he volunteers a reply—can in addition to employing language which makes all his statements nonsense, turn a fraction upside down, misplace a decimal, and, finally, pass the report of his speech for press with these blunders uncorrected, how can outsiders avoid suspecting that similar mistakes may be not infrequent in calculations upon which specifications and contracts are based, and on which very "practical" questions of success or failure, and of pounds, shillings, and pence, depend?

And now for the application of all this. The speaker gave as his reason for using volts and ohms that they are "so easy to measure, and so simply connected." Do the supporters of the "practical man" think that this easy measurement, this simple connection, came by accident? Do they think that this system which they find so useful could have been elaborated by men who, when it has been before the world for years, cannot open their mouths or put pen to paper, without showing in every sentence that they are absolutely ignorant of the fundamental conceptions on which the whole system is based, and equally incapable of using it correctly?

In the course of the evening the same speaker claimed for himself and for practical men that "we don't want to know what [electricity] is, but what it will do." He, and such as he, have yet to learn that what electricity has done is mainly the outcome of the work of men who did want to know what it is, being certain that if they knew that they could make it do more than under any other conditions.

They elaborated a system of units which our authority finds *easy* and *simple*, by the aid of investigations which even now require a good knowledge of mathematics and physics on the part of those who would really understand them, and which at the date of their original performance were masterpieces which only intellects of a very high order and knowledge of a very wide grasp could have achieved. Among them were numbered some engineers, but these ranked among them not because they were practical men who did not "want to know what electricity is," but because they had risen above such wretched cant, and had become not only "practical" but scientific.

The mischief done by the Bath meeting is not yet ended. It may or may not be a good joke to discuss whether Sir William Thomson is or is not an engineer. But the views then expounded are, all over the country, leading so-called "electrical engineers," who are ignorant of all that concerns what is, by their own confession, the easy part of their subject, to fling their cheap sneers at men who do "want to know what electricity is," who have made it possible to use and measure electrical quantities, and who have directly or indirectly created the very trades by which their detractors earn their daily bread.

"We don't want to know" will be the ruin of British industry, unless its leaders use their influence to crush the spirit indicated by this expression. In the March number of the *Fortnightly Review*, Lord Carnarvon relates that chairs, of which the various parts are fastened by glue, as is the custom in this country, will not hold together in the warmer climate of Australia. English makers did not know, perhaps did not "want to know, this. "The Austrian manufacturers, on the other hand, had discovered the cause of the defect, and, by a very simple alteration in the fastening, had practically driven out of a large part of the country our home-made furniture." "Wherever I went," says Lord Carnarvon, "I observed that, as a matter of fact, German, and not English, furniture was in use." And so, while the columns of every newspaper are full of the unity of the Empire, and of the unemployed, another tie between mother-country and colony is broken, another outlet for British industry is closed, because our manufacturers do not know what the Austrian discovers for himself.

It is all of a piece with this that in England, in the year of grace 1889, an electrical engineer, who is, as we gather from the Chairman's statement, no tyro or underling, but who was welcomed at an important meeting as a worthy exponent of the views of a well-known firm, was not ashamed to tell his hearers that he does not "want to know what electricity is," and that he could "measure all electrical quantities in foot-pounds."

THE CEPHALOPODA.

Catalogue of the Fossil Cephalopoda in the British Museum (Natural History), Cromwell Road, S.W. Part I., containing part of the Sub-order Nautiloidea, consisting of the Families Orthoceratitidæ, Endoceratidæ, Actinoceratidæ, Gomphoceratidæ, Ascoceratidæ, Poterioceratidæ, Cyrtoceratidæ, and Supplement. By Arthur H. Foord, F.G.S. Pp. xxxii. and 344, and Fifty-one Woodcuts. (London: Printed by Order of the Trustees, 1888.)

JUST as heraldry in the Middle Ages formed a necessary part of the education of every knight and noble, without which it would have been impossible to trace the connection of the great families whose genealogy was symbolized on banner, shield, and crest, so palæontology is essential to the biologist, if he would successfully trace the connection of the living forms around him with their remoter progenitors whose records must be sought for in rocks of Palæozoic age.

Of such high lineage are the Cephalopoda, whose ancient life-history Mr. A. H. Foord has essayed to write in the carefully-prepared volume before us. There is evidently a fascination about the nautilus and cuttle-fish family, which seems specially to attract the attention of naturalists. The living animals of the cuttles and squids are remarkably vivacious, as well as cosmopolitan, whilst the Octopus, or "devil-fish," has been invested with quite supernatural powers and intelligence. As to the gigantic calamaries of the North Atlantic, they almost realize in size De Montfort's fancy sketch of the "colossal poulpe" seizing a three-masted ship in its arms; or the fabled "Kraken," described by Dr. Paullinus and the Bishop of Bergen in the last century as a beast so huge that a regiment of soldiers could conveniently manœuvre on its back!

Striking and varied as are the animals of living Cephalopods, their shells, both recent and fossil, are of immense interest, indeed they are unsurpassed for elegance and variety of form by any of the Molluscan sub-kingdom; and as we have seldom the other parts left to us—especially in the older rocks—save the shell alone, it becomes necessary to study these structures with increased attention, and strive to elicit from them all that is possible of the past life-history of their inhabitants, and thus, by the light which they afford us, to trace the origin of the allied living forms.

The labours of naturalists during the past fifty years have tended to eliminate certain groups formerly classed with the Mollusca, and thus to define more clearly the characters of this great phylum of the Cœlomata as now recognized. The first group to be removed from the Mollusca was that of the Cirripedia by the labours of J. V. Thompson in 1830. In 1866, Kowalewsky showed that the Tunicata had affinities with the Vertebrata, and that their agreement with the Mollusca was only superficial. In 1844, H. Milne-Edwards had placed the Polyzoa with the Brachiopoda and Tunicata in a large group, the "Molluscoidea"; but the investigations of Cardwell, in 1882, showed that the Polyzoa and Brachiopoda had only a delusive agreement with the Mollusca, and must be removed from that phylum also.

There now remain, according to Prof. Lankester, only two great branches of the Molluscan phylum; namely, (1) the GLOSSOPHORA (characterized by possessing an odontophore), embracing the Gasteropoda, the Scaphopoda, and the Cephalopoda; and (2) the LIPOCEPHALA (= *Acephala*, Cuvier), including all the Lamellibranchiata (mussels, oysters, cockles, clams, &c.), without any definite head.

The question that interests us most to-day is, To which of the Mollusca belongs the honour of representing the primitive type from which all the varied forms we now recognize have arisen? Leaving out of consideration the earlier Brachiopoda, as having been already excluded from the Mollusca, we find in the older Palæozoic rocks that the Pteropoda, Heteropoda, Nautiloidea, and Lamellibranchiata (or Lipocephala) appear almost contemporaneously. But the Pteropoda (represented by *Theca* and *Conularia*), and the Cephalopoda (by *Orthoceras sericeum*, and at least three other species), begin in the Tremadoc rocks; Lamellibranchs (such as *Palæarca* and *Ctenodonta*) in the Arenig; whilst Gasteropods of several well-marked genera (*Murchisonia*, *Pleurotomaria*, *Euomphalus*, *Trochus*, &c.), with *Bellerophon* and the strange *Maclurea*, are found in the Bala series. If, as appears from the views of Prof. Lankester, we are to regard the *Lipocephala* as degenerated forms of *Glossophora*, they must have begun very much earlier indeed to have become so differentiated as we find them in the Arenig group. Nor do the Gasteropoda of the Bala series present the appearance of primitive forms (unless it be the genus *Maclurea*), for we find mollusks with turreted, turbinate, and discoidal shells, already defined as distinct generic types.

That the Pteropoda preceded the higher Cephalopoda in time seems pretty certain, and that both of these preceded the Gasteropoda seems established; but of the priority of the latter over the Lamellibranchiata there is no evidence.

As Prof. Lankester, in his recent classification of the Mollusca, places the Pteropoda with the Cephalopoda as Branch A. *Pteropoda*, Branch B. *Siphonopoda*, we must be content, for the present, to consider that the Cephalopoda represent the most ancient type of Mollusca, and that the shells of the little Pteropod, *Theca*, are the earliest representatives which we at present know.

In *Orthoceras* we become acquainted with the first and simplest form of camerated Cephalopod shell. They were straight shells, with plain suture-lines marking the septa, the siphuncle varied in position, the septa being concave towards the aperture; the initial chamber was conical, with a cicatrix, the body-chamber large, and its aperture simple (pp. 1–128). Nearly 200 species of these straight simple shells are described by Mr. Foord, ranging from the Tremadoc shales of Portmadoc to the Trias of St. Cassian. That they were external shells is proved by their surface-ornamentation, consisting of transverse and longitudinal ridges, and fine decussating striæ, with occasional colour-bands and markings rarely preserved.

In *Endoceras* (pp. 129–63) the internal structure of the shell is varied by the undulating character of the septa, which bend downwards, and overlap the neck of the preceding septum, forming a complete shelly siphuncular tube. The siphuncle, moreover, is eccentric in position, and often half the diameter of the shell. Within this wide siphuncle a series of funnel-shaped conical sheaths (endosiphons) have been observed, of the nature of which we are at present left in doubt. *Piloceras* has also an unusually large siphuncle, within which a series of invaginated sheaths, similar to *Endoceras*, occur.

The genus *Actinoceras* presents other peculiarities in the structure of the shell. Within the siphuncle, which is very large, a slender tube passes down the centre, called the endosiphon (pp. 164-99). The siphuncle expands between each septum into a broad bead-like dilatation, perforated around its periphery by a series of minute shelly radiating tubuli given off from the endosiphon. It has been suggested by Owen that these were connected with the vascular system of the animal, and were designed to convey nutrition to the lining membrane of the septal chambers. No such complex siphon and endosiphon exists in the shell of any living Cephalopod; nevertheless, it is difficult to accept for them the interpretation here suggested, unless we would invest the shells of these ancient Mollusca with a structure akin to that of the skeletons of the Vertebrata!

The huge siphuncles of *Huronia*—allied to *Actinoceras*—have been described by Stokes, Bigsby, Hall, and

Woodward (pp. 199–207). The septa and shell-wall are thin, and but rarely preserved. These weathered tubes were frequently noticed by Dr. Bigsby standing out in relief from the limestone cliffs of Drummond Island on Lake Huron, and were as large as the vertebra of a man, and not unlike them in shape, and over 6 feet in length.

In the family of the *Gomphoceratidæ* (pp. 211–45), we meet with shells ranging from nearly straight, through varying degrees of curvature, to one in which a complete whorl is attained. The aperture of the shell in this family is so contracted that it is obvious the animal could not have withdrawn its head into its body-chamber as does the living *Nautilus*. The mouth of the shell is T-shaped, and reminds one of the mouth of the shell in some land-snails, like *Helix globulosa* and *Auricula scarabæus*, which are so guarded by tooth-like projections from the margin of the aperture as seemingly to preclude the animal from ever retreating into its shell, or emerging from it if withdrawn.

The *Ascoceratidæ* (p. 246) have the test of a sac-like form, the body-chamber extending to the lower end of the dilated portion of the shell, while the septa adhere to the dorsal wall, and bend upwards with their convex side towards the mouth of the shell. The apex was unknown, the shell being always found truncated, but Barrande, first, in Bohemia, and subsequently Lindström in Sweden, have discovered the earlier apical portion of the shell of *Ascoceras*, which was nearly straight, and with the septa normal, as in *Orthoceras* (p. 335).

The *Cyrtoceratidæ* (pp. 262–318) are more regular in their growth than the preceding; the shell is more or less curved, and tapers rapidly, or more slowly, according to the species or variety examined. The siphuncle is small, and varies in position in the different species, being external, internal, or sub-central; they range from the Carboniferous to the Tremadoc series, and are well represented in the Devonian of Gerolstein, Eifel, by large and handsome forms.

In his introduction the author discusses many points of great interest relating to the class, as, for example, the classification, the structure of the shell, the range in time, and the distribution of the group.

Seventeen genera and 403 species are described, but there yet remain the *Lituitidæ*, *Trochoceratidæ*, *Nautilidæ*, and *Bactritidæ*, to complete the NAUTILOIDEA; while the AMMONOIDEA and the DIBRANCHIATA will be treated of still later on.

Mr. Foord writes:—

"The classification of the Nautiloidea adopted in this volume will be found to differ in some of its details from systems hitherto employed, the more recent writings of Noetling, Zittel, Mojsisovics, and Hyatt having furnished the basis of the changes introduced. The arrangement of the groups described in the following pages is primarily zoological, secondarily stratigraphical, each genus being dealt with separately, from its appearance to its extinction."

The author passes in review the various systems of classification of the Cephalopoda proposed by Prof. Hyatt, Dr. Paul Fischer, Barrande, and other writers on this group.

"Hyatt considers that the generic terms *Cyrtoceras*, *Gyroceras*, *Lituites*, *Nautilus*, are merely 'descriptive terms for the different stages in the development of an individual, and also the different stages in the development or evolution of the adult forms in time. In other words, each of these genera, as now used, includes representatives of all the different genetic series of Tetrabranchs, which are either young shells in the corresponding stage of growth, or adult shells in the corresponding stage of evolution.' He finds 'that genetic affinities on a large scale are best exhibited by the siphuncle, particularly by the funnels of the septa, which are more invariable than any other part of the shell.'

"He next discusses the embryonic relations of the structure of the septa and of the siphuncle, and mentions the difference between the Nautiloids and the Ammonites exemplified in these structures, the one commencing with a globular initial chamber ('protoconch' of Owen), the other with a conical initial chamber and a cicatrix. He remarks that generally among the Palæozoic Cephalopod types much greater differences exist, in regard to the septa, the position of the siphuncle, and so on, than among the Mesozoic forms, thus indicating that the evolution of forms was quicker in the Palæozoic epoch than at subsequent periods, and from these circumstances he concludes that 'types are evolved more quickly, and exhibit greater structural differences between genetic groups of the same stock, while near the point of origin, than they do subsequently.' It must not be forgotten, however, that the Palæozoic epoch was of much longer duration than the Neozoic. 'In the smaller divisions (families and genera) of Hyatt's scheme of classification, an important place is assigned to the characters of the sutures for distinguishing the different groups. In some groups, however (notably the Orthoceratidæ), the less stable characters presented by the ornamentation of the shell are for a like purpose employed.'

"While there can be no question as to the value of Prof. Hyatt's work, and the thoroughness of research which he has brought to bear upon the class he has with so much boldness and originality attempted to re-classify, the extremely revolutionary nature of the changes he has proposed in the minor divisions of his system (involving the wide separation of many forms hitherto associated together) challenges the inquiry as to whether our knowledge of the developmental history of the Cephalopoda is not as yet far too imperfect to justify such a radical departure from existing systems. The suppression of the familiar names *Cyrtoceras* and *Gyroceras* seems quite unnecessary, and seeing that the names *Orthoceras* and *Nautilus* are retained, in a restricted sense, in Hyatt's scheme, there seems to be no good reason why the two former should not have been similarly used" (Introduction, p. vii.).

Mr. Foord discusses at some length the nature of the camerated structure of the Cephalopod shell, and the question as to whether the *camera* should be called "air-chambers" or "water-chambers"; he concludes to avoid the difficulty by calling them "septal chambers." Bearing in mind the fact that each sealed-up chamber of the shell is but the partitioned-off lower portion of the animal's body-chamber, it is obvious that it must, at the moment of separation, contain the same medium as that which envelopes the animal.

In the case of the living *Nautilus*, dredged by the *Challenger* off Matuku Island, in 320 fathoms,[1] it seems improbable that the "septal chambers" could have been full of gas when the animal was crawling upon the sea-bed at a depth at which the pressure would be equal to about 750 pounds on each square inch of surface, or fifty-three times greater than at the sea-level. Any such inclosed gas-filled chambers would have sufficed, by their buoyancy, to bring the shell and animal at once to the surface.

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[1] See "Notes of a Naturalist on the *Challenger*," by H. N. Moseley, M.A., F.R.S. (p. 297).

That the living Nautilus, noticed by Prof. Moseley, should have been unable to sink in the tub of sea-water in which it was placed on the deck of the *Challenger*, and that this inability was due, as he observes, "to some expansion of gas in the interior, occasioned by the diminished pressure," is equally certain; but Moseley does not state that the expanded gases were in the shell-chambers; had such been the case, the gas, in order to expand, must have ruptured the rigid shell-wall. But gases are, no doubt, evolved within the crop and alimentary canal of the animal, and these, by their expansion, on coming to the surface, would suffice to produce the effect observed by Moseley. "The living specimen," he says, "seemed crippled, and unable to dive, no doubt because it had been brought up so suddenly to the surface from the depths" (*op. cit.*, p. 298). Exactly similar effects were observed in fishes with "swim-bladders." These "come up" (says Moseley), "in the deep-sea dredge, in a horribly distorted condition, with their eyes forced out of their heads, their body tense and expanded, and often all their scales forced off" (*op. cit.*, p. 580).

Mr. Foord quotes an observation by Dr. Woodward, "that many dozens of specimens of newly-imported shells of *Nautilus*, examined by him at the Docks, were, when shaken, all found to contain fluid within their chambers, just as in the camerated shell of the Water Spondylus (*S. varians*)" (Introduction, p. xiii.). We cordially indorse Mr. Foord's remark that "it is much to be regretted that recent opportunities of setting this question (of the contents of the septal chambers) at rest should apparently have been neglected."

What we would strongly insist upon is, that, it being admitted on all hands that the Cephalopoda are, in every respect, Glossophorous Mollusks, their shells must, in a similar manner, be found to conform to the ordinary Molluscan type. The striking regularity of their septal chambers has usually hindered a comparison with those of other camerated Molluscan shells; but in *Caprinella*, the camerated interior of the "water-chambers" is quite equal in regularity and symmetry with that of the Cephalopoda, and many of the *Hippuritidæ* show not only septa, but a pseudo-siphuncle, reminding one still more of the chambered Nautilus.

Space does not permit a longer notice of Mr. Foord's excellent "Catalogue"; it is a most valuable addition to the now really fine series of descriptive Catalogues issued by the Trustees of the British Museum of Natural History. We hope soon to welcome the appearance of the second part of this useful work, when we may be tempted to reopen the question of shell-growths and shell-structures.

SANITARY SCIENCE.

Transactions of the Sanitary Institute of Great Britain. Vol. IX. (1887–88.)

THIS volume is largely composed of the papers and addresses read at the Congress of the Institute at Bolton. The authors are chiefly men well known in their different professions, whose contributions are not only of much scientific interest, but carry weight with the public. Sanitation is a science in which the "faddist" delights to dabble, but his effusions have but little representation in the volume before us. The majority of the workers appear to be content to record steady advances in knowledge, or to make practical suggestions for administrative reform, rather than to air brilliant theories, popular with the public for their novelty, but greatly wanting in substantial proof. To force premature conclusions in sanitation, as in other older sciences, is to retard true progress; and on the whole it may be said that sanitary reformers, however earnest, are content to preach the doctrine of pure air, earth, and water, which is as old as Hippocrates.

In the department of practice, improved sanitary administration is urged on all hands. Such reforms take largely the shape of what has been called "interference with the liberty of the subject"; an interference, however, which is not unnecessary or uncalled for, but is imperative in health matters where the act or default of one individual may imperil the lives of many. Those who on this plea found their objections to such measures as compulsory vaccination, compulsory notification of infectious disease, isolation of infectious disease in hospitals, better supervision of building operations, dairies, and cow-sheds, and stricter enforcement of nuisances clauses and sanitary regulations generally, appear to forget that civilized existence depends upon the observance of mutual obligations, and that society could not exist if every individual were free to exercise his liberty of action at the expense of the community. Little is thought of the restrictions that already exist, and to which all law-abiding citizens cheerfully adhere, but when, with advancing knowledge of cause and effect in disease, certain measures are pointed to as being necessary to avoid unwholesome conditions, or to prevent the dissemination of epidemics, an outcry is raised which is too often not only illogical but insincere.

In the section of chemistry, meteorology, and geology some valuable papers are contributed on the application of bacteriology as a means of obtaining evidence as to the purity of water-supplies, and of ascertaining the degree of contamination of the air of buildings and sewers. As a science, bacteriology is still in its infancy, but already its teachings are producing a most profound effect in the domains of medicine and hygiene. The recognition of the bacterial and fungoid organisms as the principal factors in the processes of fermentation and putrefaction of organic substances, and the discovery that certain specific microbes are the actual agents provocative of certain contagious diseases, have secured a basis on which can be founded rational measures for the prevention and alleviation of disease and for the control of insanitary conditions. Hygiene was a science practised with most beneficial results before the discoveries of Pasteur, Koch, and Tyndall, but many of its teachings and precepts were at that time empirical, although founded more or less on experience and observation. With the more definite knowledge of disease causation and dissemination now arrived at, it is most satisfactory to find that the measures of sanitary reform and improvement which have marked the latter half of the present century are almost entirely in accord.